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The Evolution of Population Distribution on the Iberian Peninsula: A Transnational Approach (1877–2001)

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The Evolution of Population Distribution on the Iberian Peninsula: A Transnational Approach (1877–2001)

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Abstract. Surpassing the national perspective usually adopted, the authors confirmed the existence of a pattern of population distribution common to the whole Iberian Peninsula in the long run. This pattern is clearly associated with geographical factors. These variables seem to have more weight in explaining changes between 1877/78 and 1940 than in the period from 1940 to 2001. The observation of the cross-border region has shown that proximity to the frontier has not generated any distinct pattern of population density on either side of the boundary line. The spatial coherence of the observed phenomena throughout the Peninsula and of its evolution, independent of the border between states, reinforces the importance of geographic factors in their explanation. At the same time, this verification opens up new issues related to the effect of national political and economic policies.

Keywords: border studies, geographic information systems, Iberian Peninsula, spatial population distribution, transnational history

Population distribution patterns in Portugal and in Spain have always been an important research topic. Additionally, given the current dramatic imbalance between a small group of densely populated and wealthy regions and the rest of the territories in both countries, this subject has also become a matter of concern for society as a whole. In fact, the differences in wealth, economic, and demographic dynamism and the regional disparities in access to education, health, and other public services seriously endanger territorial cohesion and the principle of equal opportunities among citizens. Therefore, revisiting the issue of population distribution from a transnational perspective and in the long run is not only to address an important subject for research in humanities and social sciences, but to contribute to the understanding of the roots of a current social problem of great relevance.

In this article, surpassing the national perspective usually adopted, we tried to verify the existence of a spatial pattern of population distribution on the Peninsula as a whole and study its evolution. We also sought to evaluate the relevance of geographical factors to explain this pattern, and we wanted to

This work begun within the research project, "The Development of European Waterways, Road and Rail Infrastructures: A Geographical Information System for the History of European Integration (1825–2005)," developed under European Science Foundation EUROCORES programme. In Portugal, it was funded by Fundação para a Ciência e a Tecnologia. The good relationships established with the Spanish team allowed the integration of Josep Puig-Farré in our group from 2009 to 2011, a period in which we began developing the historical geographical information system on the Iberian Peninsula. The problems that we faced and the methodology to solve them were presented in several conferences in 2010, and the Iberian Peninsula was then integrated in our geographical information system website (http://atlas.fcsh.unl.pt/). We benefited from the discussions with Jordi Marti-Henneberg and Xavier Franch in July 2011 and with the colleagues attending the workshop "L' Ús dels SIG en l' Estudi de la Integració Europea (1870–2010)" held in Barcelona in March 2012, also organized by Jordi Marti-Henneberg, and funded by European Union (Jean Monnet 200215_LLP-1-ES-AJMIC).
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analyze the importance of the Spanish-Portuguese border in spatial population distribution. In the conclusion, we call the attention to some of the implications of our findings concerning the effect of political and economic policies on patterns of concentration/dispersion of population. The transnational approach and the in-depth spatial analysis supported by the geographical information system (GIS) are the main contributions of this article to the research on this subject.

The literature published in Spain about territorial population distribution and its evolution over the nineteenth and twentieth centuries is abundant. A list of the works produced up until a few years ago can be found in Olga Cos Guerra and Pedro Reques Velasco (2005). Since then, research has continued, presenting remarkable results. We will focus our attention on these more recent articles. It has been recently argued that Europe's regional inequalities worsened between 1870 and 2000. Patterns of population distribution over the same period show "stability in both underpopulated and very densely populated areas," and this happened "despite enormous changes in the factors that have determined the location of population and economic activities since 1870" (Martí-Henneberg 2005, 277, 279). Analyzing population densities within a group of European countries of different sizes and geographical positions from 1850 to 2000, Maria Isabel Ayuda, Fernando Collantes, and Vicente Pinilla (2010a) came to similar conclusions. The explanation put forth by these authors lay in the regional differences in the spread of industrialization and modern economic growth, which increased population disparities thereafter (although without profoundly affecting the spatial pattern existing in the pre-industrial era). In 2000, Portugal and Spain would be amongst the countries where such disparities were most pronounced (Dobado González 2006; Ayuda et al. 2010a).

Concerning Spain, regardless of the time period or the scale of the geographical framework, researchers agree upon the existence of a considerably stable territorial pattern of population distribution. The latter is characterized by the contrast between the coastal lowlands, where population is concentrated, and the depopulated higher territories of the interior. Madrid, located at the center of the Peninsula, is the most important exception to this general pattern. Vicente Pérez Moreda (2004), although working at the large regional area level, found evidence of such distribution as early as 1787. Rafael Dobado González (2006) and Ayuda et al. (2010b) confirmed the same pattern at the provincial level for the period 1787 to 2000. Finally, Cos Guerra and Reques Velasco (2005) and Francisco Goerlich Gisbert and Matilde Mas Ivars (2006, 2008) came to the same conclusion on the municipal scale for the twentieth century. In addition, Goerlich Gisbert and Mas Ivars (2008) and Ayuda et al. (2010a) statistically confirmed the trend for population to concentrate in the areas that already had a higher population density at the beginning of the various periods under analysis by the two groups of researchers.

Accordingly, with the exception of Pérez Moreda (who did not express his view on this issue), these authors underlined the importance of geographical factors (altitude, distance to coast, and rainfall) to explain the location of population.

The influence of geographical factors on economic development and the distribution of the world population, two distinct but inter-related phenomena, has been advocated by historians such as Paul Bairoch (1971, 118–20) and economists such as Andrew Mellinger, Jeffrey Sachs, and John Gallup (2000). The former drew attention to the effects of climate on agricultural productivity and human health. He also pointed out that climatic differences hampered the spread of agricultural innovations developed in temperate regions, which were decisive in triggering the industrialization process. To these aspects Mellinger and colleagues (2000) added the importance of access to navigable rivers and the sea, by the effect that this access has on transport.

However, if the geographical determinism of the past has been abandoned, it has not been possible to achieve a consensual view on the importance of the natural conditions in the spatial distribution of wealth and population. The Economic Geography, in general, has not given great emphasis to this issue (Wood and Roberts 2011). The New Economic Geography itself, initiated by Paul Krugman (1998), although it has reintroduced space in economic analysis does not grant importance to physical geography as well. For instance, Pierre-Philippe Combes, Thierry Mayer, and Jacques-François Thisse (2006) argued that physical factors should be taken into account in explaining geographic distribution of development on a global scale, but not in the analysis of regional inequalities in developed countries. In this case, the relevant factors to understand the concentration of economic activity and population are the combined effects of market size, economies of scale, and transport costs (Krugman 1993).

The perspectives of New Economic Geography and those of Mellinger and colleagues can however be complementary, as the latter authors suggested: "It could be, for example, that physical geography helps to explain initial differences in outcomes across regions, and that new economic geography helps to account for ways in which those initial differences are magnified" (2000, 172). Ayuda and colleagues' work on Spain explores this path (2010b). In fact, these authors suggested that geographical factors, namely altitude, distance to coast, and rainfall, which have a great influence on agricultural productivity and transportation, were decisive in explaining the concentration of economic activity and population prior to industrialization. When this process began, industries, in a search for market access, tended to localize themselves in these most populated areas. Thereafter the interaction between economy and population turned out to be a mutually reinforcing process, whereby the richer regions tended to attract a migrant population from poorer areas, which in turn helped to develop the territories where the modern economic sectors were concentrating (Paluzie et al.

2009; Collantes and Pinilla 2011). The latter also profited from scale economies and decreases in transportation costs. For this reason, at a later stage, geographical factors, though still important to explain population location, began to share this role with other factors related to this cumulative effect (Ayuda et al. 2010b).

Historians have long affirmed that the Portuguese population historically presented a denser concentration on the coastal strip to the North of the Tagus River (Marques 1987; Marques and Dias 2003). This concentration has increased from the sixteenth century onward, especially in the Northwest region where cultivation of corn, imported from America, found excellent conditions for development (Ribeiro 1945). It has recently become possible to rigorously confirm this spatial pattern since the beginning of the nineteenth century and quantify its evolution until 1930 (Silveira et al. 2011). In fact, in 1801, 46% of the population lived on that narrow stretch of coastal Portuguese territory. Up until 1864, population distribution remained stable amongst the various regions, but from this moment onward the differences grew, aggravating the structural tendency to densify in the coastal area. The construction of railroads may have contributed to this evolution (Silveira et al. 2011). Following World War II, vigorous emigration as well as migration from rural areas to the city came to strengthen the imbalance in population distribution and accentuate the separation between coastal and inland regions (Ferrão et al. 2005; Rodrigues 2008).

Border studies are currently receiving an increasing attention from researchers from various disciplines. In the case of the Spanish-Portuguese cross-border regions, the interest grew especially after the accession of both countries to
Q1 the EEC, mainly with the aim of counteracting the so-called "historical heritage of the border effect" (Moreira 2001, 7). However, the notion of border, which justifies the perspective of "differentiation, opposition and periphery," commonly used in this case, is a political and historical concept, not a geographical one (Cavaco 1995, 9–10). In fact, it is usually recognized that the Spanish-Portuguese frontier is not a "natural boundary," in most part (Moreira 2001, 8). Some of the references that deal with the border do not have a historical depth, focusing their analyses mainly on the period from the 1980s onward, or they address only one segment of the boundary line. Besides, they verified the existence of similar demographic behaviors on both sides of the frontier in the last decades of the twentieth century (Cavaco 1973, 1995; López Trigal and Guichard 2000; Moreira 2001; Lois-González 2004; Pires and Pimentel 2004).

Daniel Tirado Fabregat and Marc Badia-Miró (2012) recently argued that these regions were among the poorest of the Peninsula. At the same time, they defended that the border did not break the economic continuity of the zone. This is an important feature to highlight, because it is frequent in the works cited above that the analysis of the border regions is frequently done isolating them from the wider zones to which they belong, thus artificially reinforcing the aforementioned "border effect." This latter article and David Reher's work on Iberian cities (Reher 1994) are among the few that adopt a supranational perspective and are relevant for our purpose.

As this short review suggests, research carried out in Portugal and Spain has been mostly focused on national contexts. It is true that Spanish researchers studied spatial population distribution in Europe in order to find references to understand the history of their own country. However, neither the Spanish researchers nor their Portuguese colleagues have paid much attention to the evolution of the Iberian Peninsula as a whole. Only by understanding the strength of nationalist traditions can we perceive how, both in humanities and in social sciences research as well as in everyday life, it continues to be acceptable to conceive the reality of the two countries independently of one another.

In fact, the two states do share a territory marked by significant natural contrasts, which nevertheless constitutes a single geographical entity. The border between the two countries is a political construct whose origins lay in the Roman Empire. It was formally established at the end of the thirteenth century (1297) and suffered minor changes in 1801. However, this enduring frontier separates regions with similar geographical characteristics.

The intersection between geographical and political factors creates a challenging setting for research. It stimulates a transnational approach to the study of spatial population distribution in the long run and the re-examination of the importance of natural factors in the explanation of population concentration/dispersion, a topic that has been discussed for a long time, about which more empirical research is needed. In this article, regardless of national frontiers, we will then address the three issues mentioned in the beginning: patterns of spatial population and their historical evolution; the importance of geographical factors to explain population location on the entire Iberian Peninsula; and last but not least, the influence of the Spanish-Portuguese border in population location. The main hypotheses underlying this approach are the following: (a) patterns that have been separately identified in Portugal and in Spain are part of a historical process taking place within the vast peninsular territory regardless of national states; (b) geographical factors had a decisive importance in population location from the beginning of the period analyzed; and (c) that relevance was perpetuated into the second half of the twentieth century. Q2

Bearing in mind the subject of this article and the importance given to geographical factors, we excluded from the analysis the islands and archipelagos belonging to both countries. The period under consideration begins in 1877 for Spain and in 1878 for Portugal and ends in 2001. The definition of the starting years was conditioned by the availability of data. In fact, they correspond to the oldest censuses which provide information on resident population at the municipal level in the Spanish case and the parish level for Portugal. We divided the time span into two periods: 1877/78–1940 and 1940–2001. The turning point corresponds to the

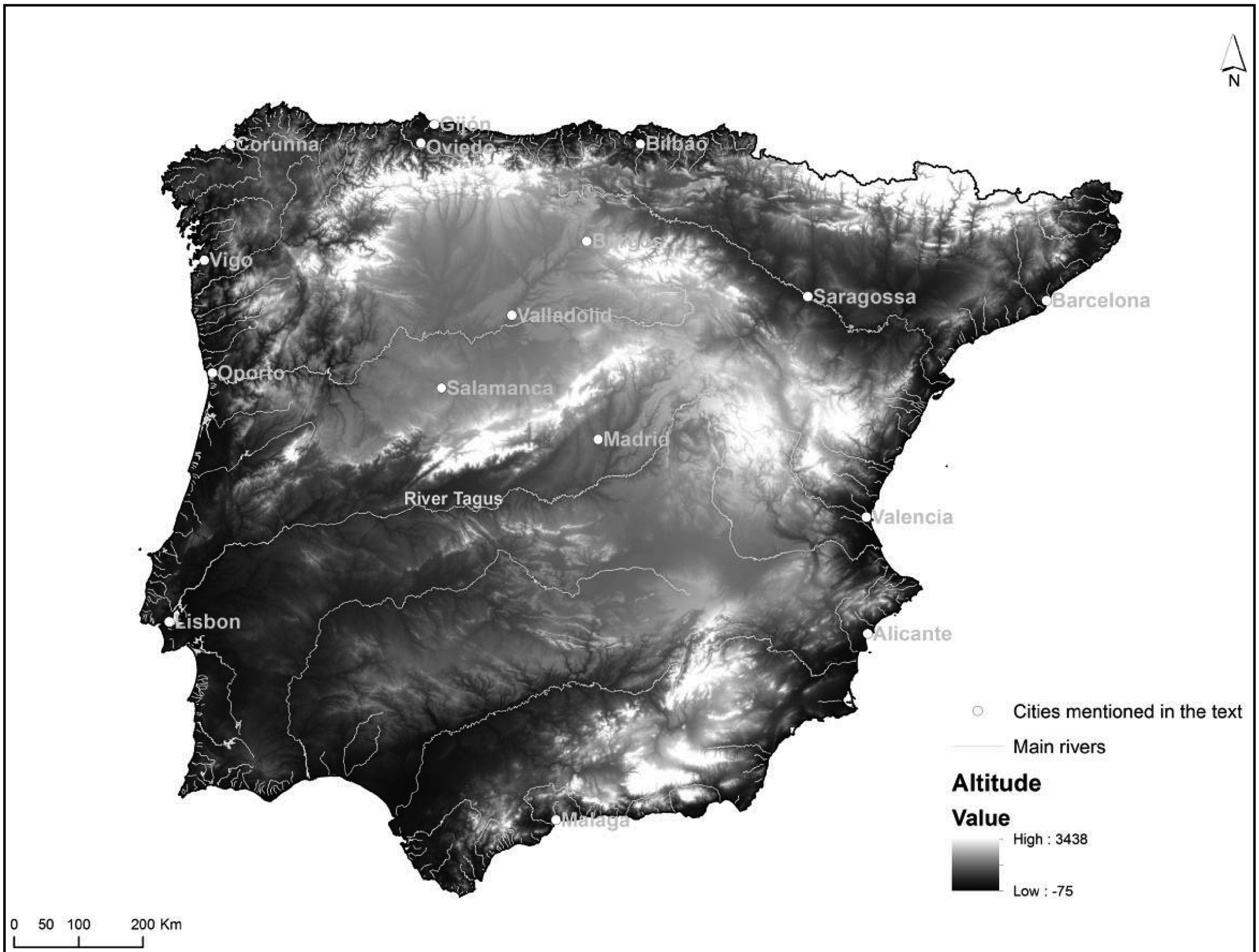

FIGURE 1. Altitude and main rivers in the Iberian Peninsula.

beginning of World War II, which separates an era of slow economic growth and limited modernization from the post-war decades filled with rapid economic and social change (Tortella 1994; Carreras and Tafunell 2010; Costa, Lains, and Miranda 2012). Data on population evolution permit other alternatives, either before or after the selected year. However, our choice also had the purpose of creating two periods with a similar duration, comprising minimum number of demographic observations or population censuses. This feature is important for the statistical computations.

Data and Methods

Data

We adopted population density as a measure of population concentration and dispersion. As our objective was to analyze the influence of geographical factors, it was apparent that we should work with the greatest detail possible. For this reason, we took Spanish municipalities and Portuguese parishes as our frame of territorial reference. In fact, it is only at this level that certain analyses such as proximity to rivers or the border begin to make sense. Moreover, in this way all the analyses gain rigor. The choice of these territorial parcels obeys yet other criteria which we will present below. One study at this scale has already been undertaken in Spain by Cos Guerra and Reques Velasco (2005) and Goerlich Gisbert and Mas Ivars (2008), but not in Portugal. These authors worked, however, not with density, but with number of inhabitants. We also estimated the trend value of population density in each study period (1877/78–2001; 1877/78–1940; 1940–2001). Population data came from the 13 Portuguese and Spanish censuses carried out from 1877 (Spain) and 1878 (Portugal) up to 2001. Given the availability of a homogenous series of resident population data for the period 1900–2001 in Spain (Goerlich Gisbert and Mas Ivars 2006), we completed that

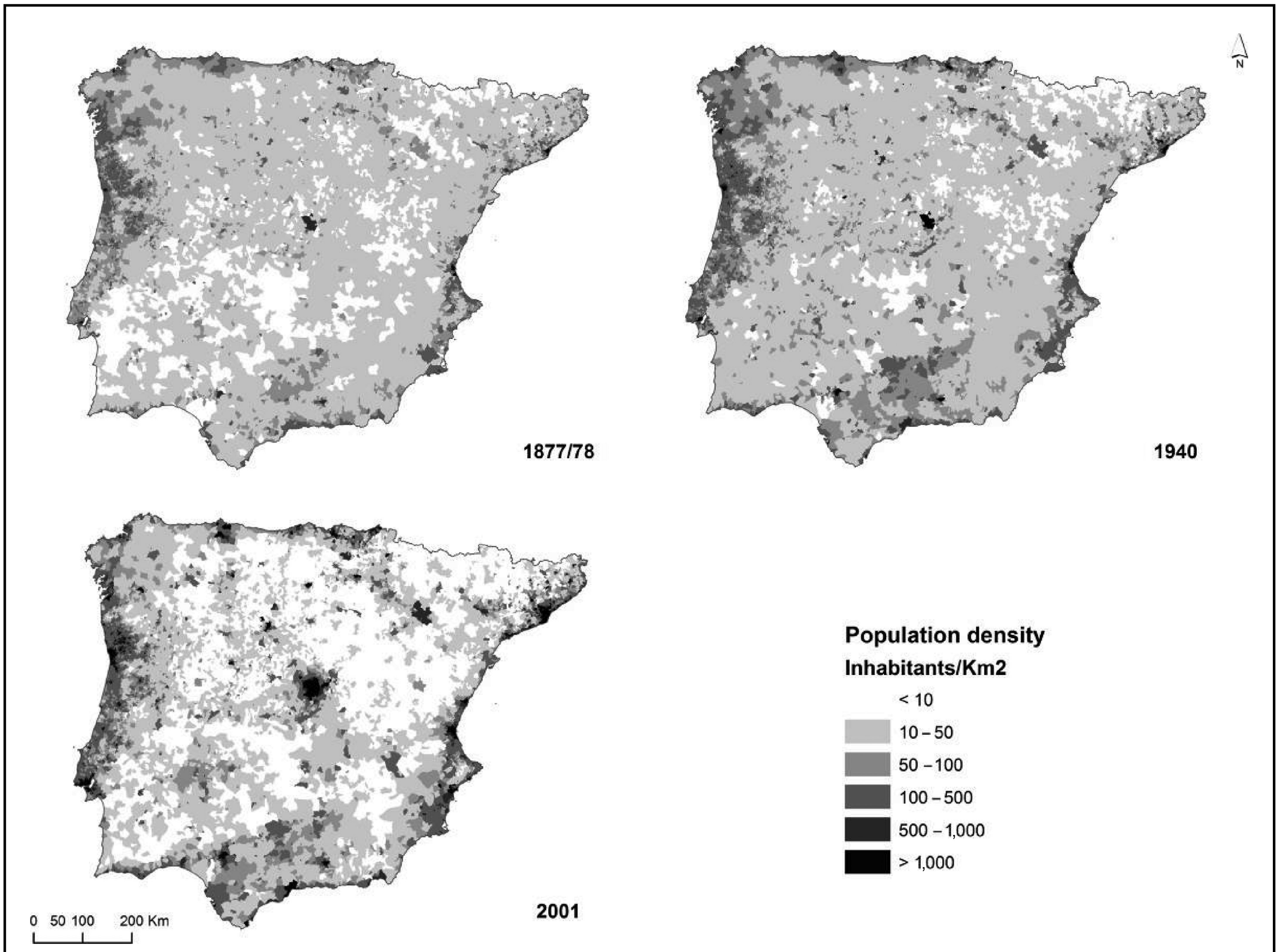

FIGURE 2. Population density in 1877/78, 1940, and 2001.

information for the years 1877–1900 and collected the same variable for Portugal.

In reference to geographical variables, we included altitude, distance to the coast, and rainfall as did the authors cited in our introduction. To these variables we also added average temperature and distance to main rivers, defined as those that flow directly toward the sea. As indicated at the beginning of this article, these factors would decisively influence agricultural productivity, transportation, and access to drinkable water and thus affect population distribution. For reasons previously mentioned, we also analyzed the distance to the border between Portugal and Spain.

We took into account the altitude of the local parish and municipal main agglomeration and the average altitude of each of these territories. These data were obtained from Q3 a DTM for all the Iberian Peninsula, with a spatial resolution of 200 m × 200 m, constructed for a previous research project (Silveira et al. 2011). Distances to the coast, to the main rivers, and to the border were calculated using the central point of the main population agglomeration of each parish/municipality. These points were provided by the *Carta Administrativa Oficial de Portugal 2012.1* and, in the case of Spain, by the *Nomenclátor Geográfico de Municípios y Entidades de Población*[1] Precipitation and temperature correspond to the annual recorded average and were obtained from the *Digital Climatic Atlas of the Iberian Peninsula* (Ninyerola i Casals, Pons, and Roure i Nolla 2005)[2] These maps also have a spatial resolution of 200 m × 200 m and were generated through spatial interpolation techniques based on monthly and annual precipitation [temperature] series with at least 20 [15] years of data in the period 1950–99 (Ninyerola i Casals, Pons, and Roure i Nolla 2007a, 2007b).

Methods

The information management and spatial analysis for this project benefited from the work done on the Iberian Peninsula Historical Geographic Information System which began

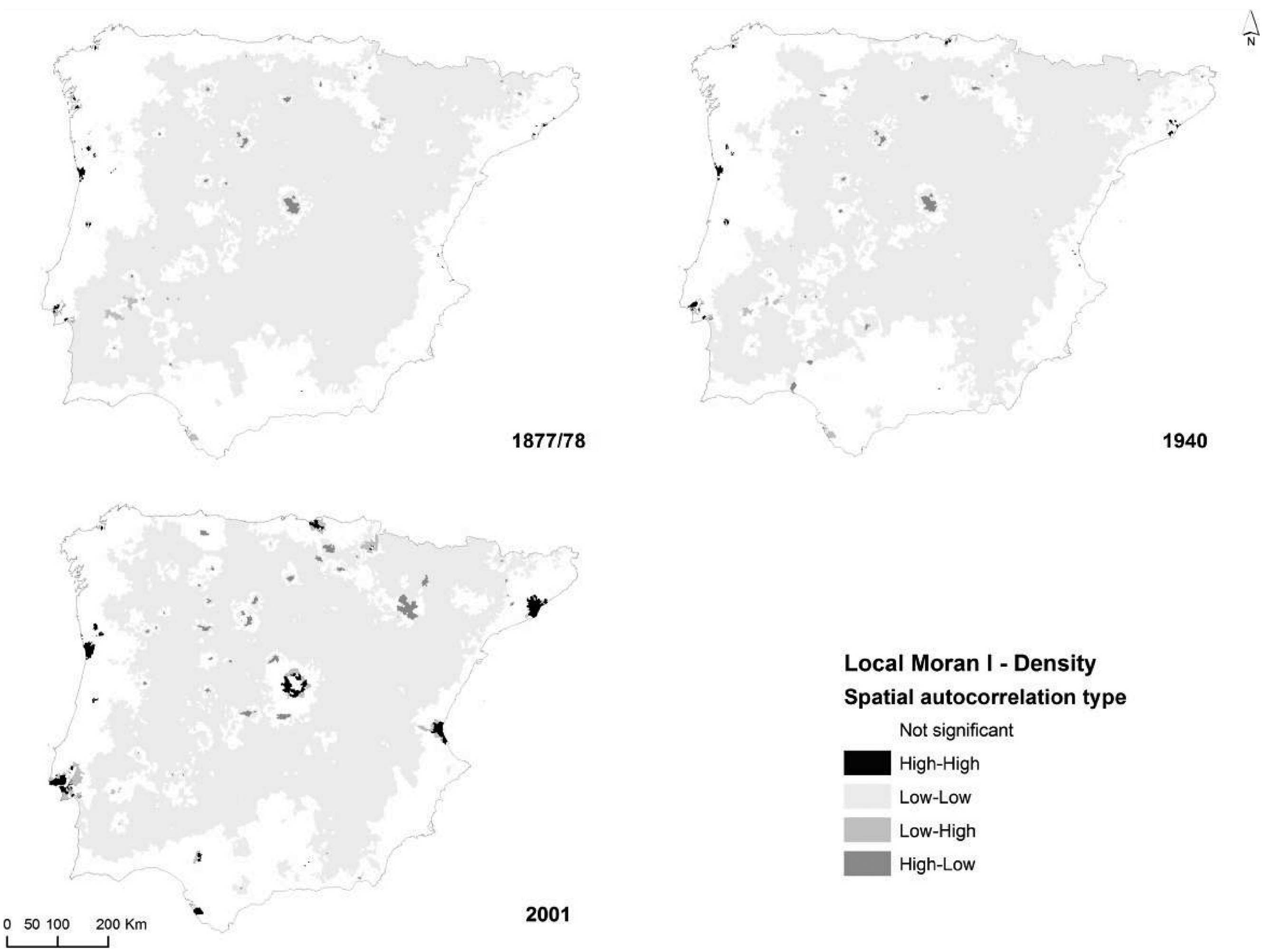

FIGURE 3. Spatial autocorrelation of the population density in 1877/78, 1940, and 2001.

a few years prior. In this system, we merged the base administrative maps of Portugal and Spain for the year 2001. The system also includes the information mentioned in the previous section.

Geographic units and transnational analysis. The analysis of the spatial distribution of a quantitative variable across the territory of two countries requires the adoption of administrative units of similar size. The difficulty is that for the same administrative level, the divisions in Portugal and in Spain were not historically equal in their extension, nor are they currently. From the largest to the smallest, and from the highest political and administrative level to the lowest, there are districts, municipalities, and parishes in Portugal, and autonomous communities, provinces, and municipalities in Spain. The analysis of the average areas of the administrative divisions led us to the conclusion that only the combination of districts with provinces or of Portuguese parishes with Spanish municipalities would be acceptable, even if they did not occupy the same position in the respective hierarchy.

We finally opted for the latter combination, as these administrative units are the smallest in both countries, allowing not only the in-depth analysis required in this research, but also the reconstitution of higher territorial divisions, thus enabling more aggregate studies. Although seemingly the best approach, this choice does not eliminate differences in extent between Portuguese parishes and Spanish municipalities and their disparity across the Peninsula from North to South, which can be clearly seen on a map. These differences affect the maps which represent population density and introduce some bias into quantitative analysis.

Data interpolation. To overcome the problems caused by the changes in territorial units over time, data on resident population from both countries were interpolated into a 2001 map. In the Spanish case this was done "manually," without any GIS, and the reconstitution of the historical population of

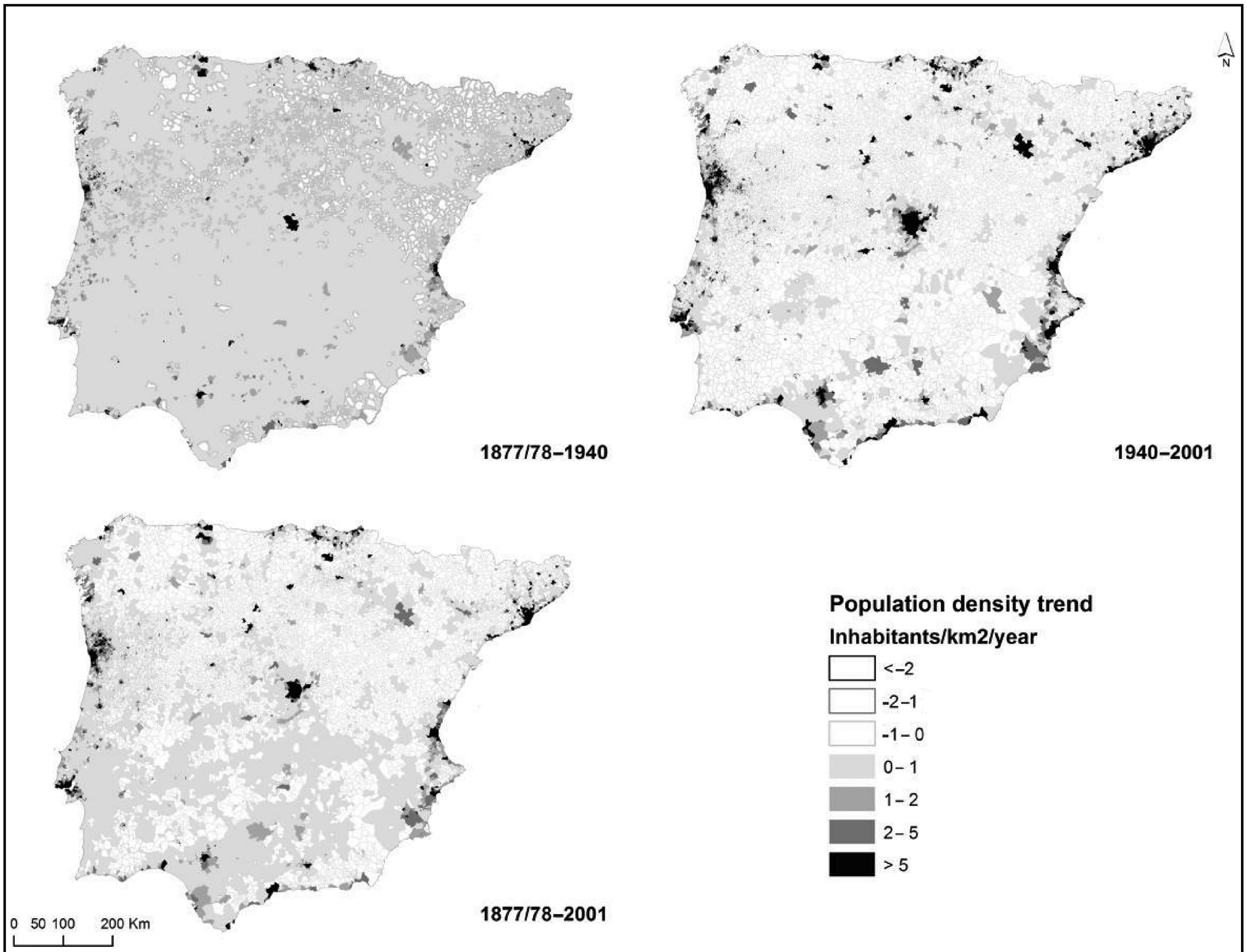

FIGURE 4. Population density trend between 1877/78–1940, 1940–2001, and 1877/78–2001.

a 2001 municipality was based on the information regarding population settlements included in its territory in 2001 provided by the previous censuses (Goerlich Gisbert and Mas Ivars 2006). Regarding Portugal, two geographic data interpolation methods, previously tested in an earlier work, were used: the areal-weighting interpolation in urban areas, currently used in this type of studies (Gregory and Ell 2007), and a second method, using the distribution of population in the parishes during the target year (2001) as simplified ancillary data in the interpolation process[3] In any case, the overwhelming majority of the Portuguese population from the distinct censuses were not affected by the interpolation process since the parishes in which they lived did not undergo any boundary changes (Silveira et al. 2011).

Local spatial autocorrelation. The local version of Moran's I, which is a measure of spatial autocorrelation, can be used to identify local spatial clusters and spatial outliers (Anselin 1995). The cluster maps depict locations classified by type of association, with significant (5% level) Local Moran statistics. The locations classified as "high-high" and "low-low" suggest clustering of similar values (positive local spatial autocorrelation) and correspond to parishes/municipalities with high [low] values that are surrounded by parishes/municipalities with high [low] values. The "high-low" and "low-high" locations are termed "spatial outliers" (negative local spatial autocorrelation), corresponding to parishes and municipalities with values that are significantly different to those of their nearest neighbors.

The computation of the Local Moran I statistic requires conceptualizing the spatial relationship between parishes/municipalities, which was done by using a criterion known as second order queen contiguity. The first order criterion establishes that only neighboring parishes/municipalities that share a boundary will influence computations for the target parish/municipality. The second order criterion

TABLE 1. Distribution of the Population According to the Density Trend (1877/78–2001)

	Decreasing	Not significant	Increasing	Decreasing (%)	Not significant (%)	Increasing (%)
Parishes/Municipalities	3,777	4,977	3,376	31.1	41.0	27.8
Km^2	163,855.6	267,947.9	153,139.3	28.0	45.8	26.2
		Inhabitants			% Inhabitants	
Years						
1878	4,439,352	6,902,807	9,071,866	21.7	33.8	44.4
1890	4,486,029	7,367,826	9,863,272	20.7	33.9	45.4
1900	4,450,460	7,809,825	10,877,361	19.2	33.8	47.0
1911	4,532,551	8,493,770	12,038,001	18.1	33.9	48.0
1920	4,408,565	8,884,265	13,458,811	16.5	33.2	50.3
1930	4,254,425	9,476,823	15,562,867	14.5	32.4	53.1
1940	4,114,707	10,061,818	18,157,564	12.7	31.1	56.2
1950	3,902,001	10,284,882	20,544,381	11.2	29.6	59.2
1960	3,480,566	9,813,573	24,224,925	9.3	26.2	64.6
1970	2,671,223	7,927,059	29,735,724	6.6	19.7	73.7
1981	2,200,616	7,024,260	35,656,603	4.9	15.7	79.4
1991	1,931,538	6,486,119	37,503,515	4.2	14.1	81.7
2001	1,785,662	6,262,745	39,994,245	3.7	13.0	83.2

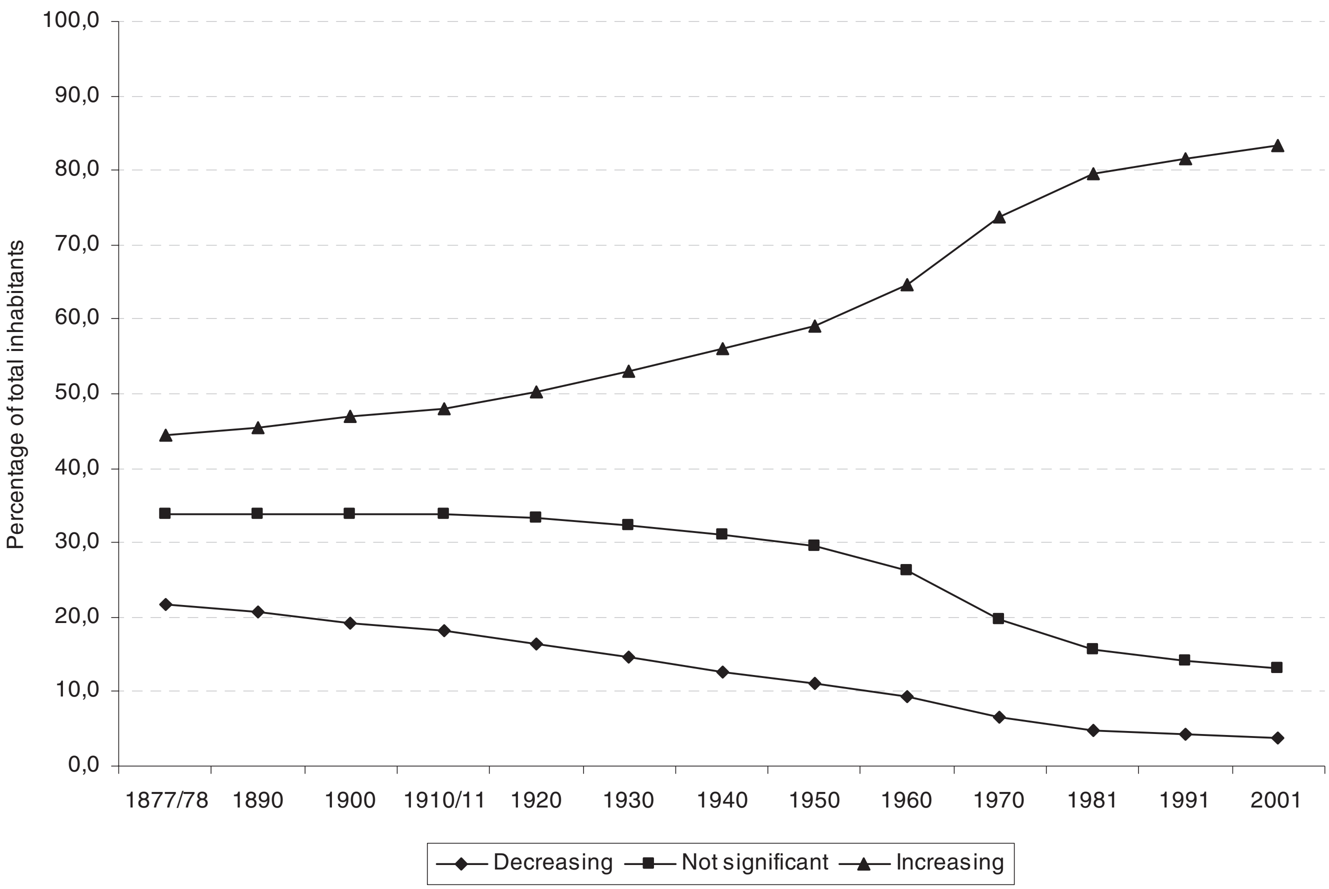

FIGURE 5. Distribution of the population according to the density trend (1877/78–2001).

TABLE 2. Association Between the Population Density in the Starting and Ending Year of Each Study Period, Measured by the Spearman's Correlation Coefficient (R)

Study period	R	*p* value
From 1877/78 to 1940	0.9305	.0000
From 1940 to 2001	0.9117	.0000
From 1877/78 to 2001	0.8292	.0000

extends this group to include the neighbors of the first order neighbors.

Trend assessment. The computation of the trend magnitude of population density as well as the assessment of its statistical significance (5% level) were applied to each parish/municipality data of the following study periods: (a) 1877/78–2001; (b) 1877/78–1940; and (c) 1940–2001. A nonparametric approach is preferred over the traditional regression analysis because of the violation of its assumptions, particularly the homoscedasticity of the errors and the regularity of error distribution. In fact, many parishes/municipalities exhibit heteroscedastic errors (not shown), which make the statistical tests unreliable. Moreover, violations of normality compromise the estimation of coefficients and the assessment of trend significance.

The nonparametric estimator proposed by Pranab Kumar Sen (1968) was used to compute the trend magnitude for each parish and municipality within the study periods considered. To test the null hypothesis of no trend, the well-known nonparametric Mann-Kendall test (Mann 1945; Kendall 1975) was applied to each set of parish/municipality data, for each of the study periods considered. The *p* values of each test location and period correspond to the smallest level of significance, leading to the rejection of the null hypothesis within the observed data. Accordingly, there is no statistical evidence of trend for *p* values exceeding .05.

Analysis of association with geographical attributes. Considering that the assumptions of the Pearson's correlation test are violated, the nonparametric Spearman's test was applied to assess the association between population variables and the above mentioned geographical attributes. The population variables correspond to the population density of each year, and the trend magnitude of each study period (1877/78–2001; 1877/78–1940; 1940–2001). The 5% significance level was considered to test the null hypothesis of no association between two variables. Amongst the geographical attributes that are significantly associated with the population variables, an especial attention was given to those having a Spearman's correlation coefficient greater [smaller] than 0.4 [–0.4].

The Iberian Peninsula might have sub-regions where population had distinct behaviors throughout the years that may cancel out the effect of association with the geographical attributes. Therefore, in order to further understand the relationship between population evolution and geographical factors, the Iberian Peninsula was stratified into one of three different ways, depending on the trend results of the 1877/78–2001, 1877/78–1940, and 1940–2001 periods. Hence, the methodological framework was applied separately to each stratum of these three time periods. For each of the latter, a parish/municipality was assigned to stratum 1 if its population density decreased; it was assigned to stratum 2 if there was no significant trend; and it was assigned to stratum 3 if its population density increased in the corresponding period.

Results

Spatial Distribution Patterns and Their Evolution

To characterize spatial distribution of population density and its evolution on the Iberian Peninsula as a whole over 120 years, we will proceed with an analysis structured in three successive and complementary steps. In this way, beyond a geographical description of population density at three

TABLE 3. Association Between Population Density and Geographical Factors, Measured by the Spearman's Correlation Coefficient (R)

Variable	1877/78	1890	1900	1910/11	1920	1930	1940	1950	1960	1970	1981	1991	2001
Temperature	0.389	0.408	0.425	0.449	0.470	0.490	0.506	0.514	0.524	0.536	0.556	0.569	0.576
Precipitation	0.406	0.399	0.396	0.391	0.385	0.380	0.393	0.395	0.393	0.379	0.378	0.362	0.342
Altitude	−0.576	−0.589	−0.600	−0.615	−0.630	−0.640	−0.651	−0.655	−0.665	−0.682	−0.703	−0.711	−0.714
Distance to littoral	−0.585	−0.576	−0.573	−0.571	−0.577	−0.569	−0.566	−0.555	−0.553	−0.575	−0.587	−0.588	−0.588
Distance to main rivers	−0.487	−0.483	−0.485	−0.486	−0.493	−0.492	−0.490	−0.488	−0.490	−0.501	−0.507	−0.510	−0.510
Distance to PT/ES border	−0.177	−0.197	−0.209	−0.213	−0.199	−0.211	−0.250	−0.273	−0.274	−0.233	−0.231	−0.206	−0.170

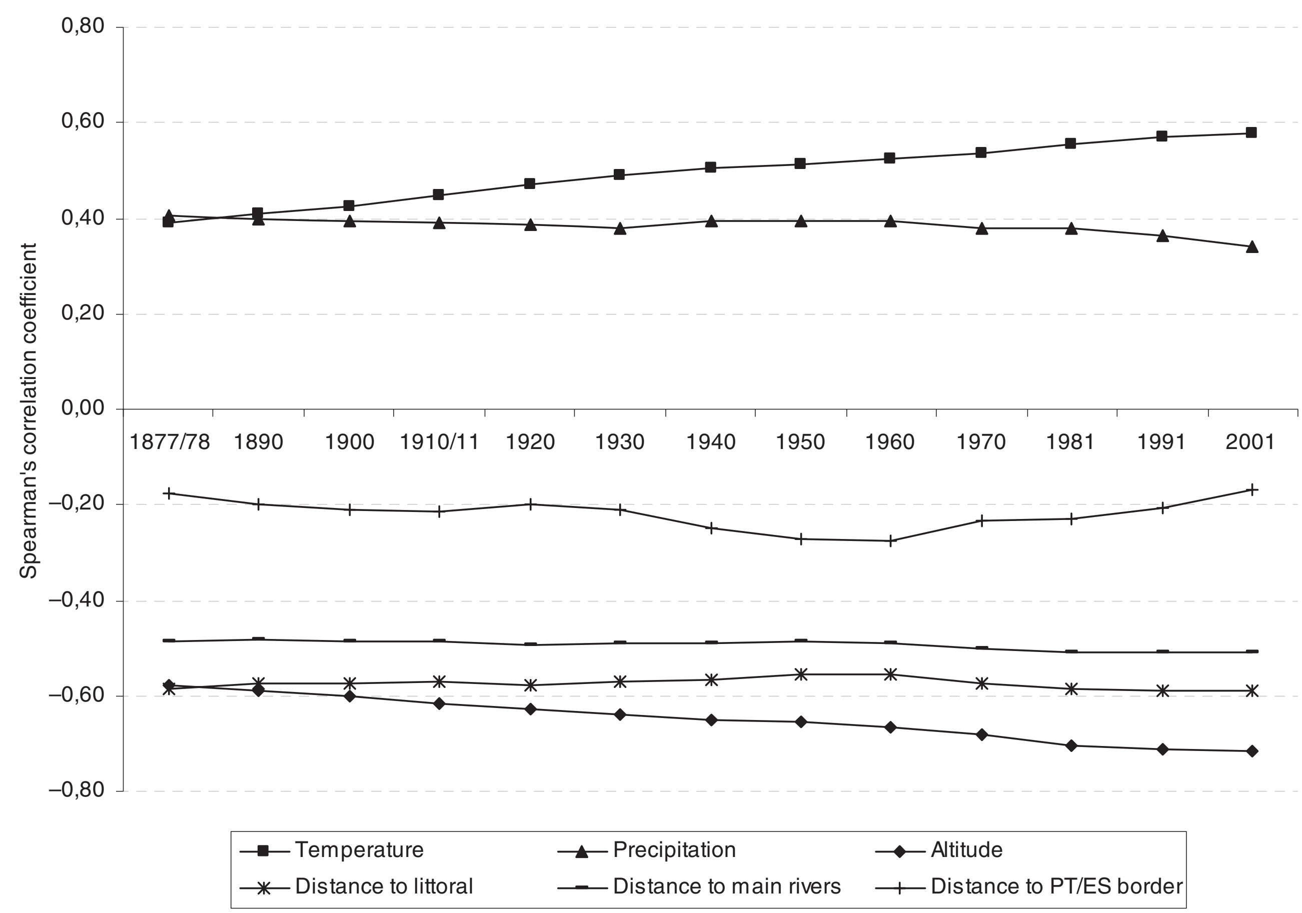

FIGURE 6. Association between population density and geographical factors (1877/78–2001).

identified moments in time, 1877/78, 1940, and 2001, we also seek to understand how each parish/municipality related to neighboring territories as a manner of identifying the autocorrelation patterns of this variable and, ultimately, analyse its evolutionary trends. See Figure 1.

Figure 2 shows population density at those three moments. In all maps, we have deliberately erased the frontier between the two countries. As we can observe, in 1877/78 population was already concentrated, to some degree, in the coastal regions. We notice a large area extending from Southern Portugal, passing through the Spanish Southern Plateau, and ending at the Pyrenees, with very small density rates. In the center of the Peninsula, between areas of high and medium density, Madrid stands out. In 1940, population densities increased almost everywhere with the exception of the region closest to the Pyrenees and a small area to the South of the Sistema Central, without breaking the general pattern. The growing density on the coastal stretch from Corunna to Lisbon should be noted as the outgrowth of some of the Peninsula's urban inland areas. However, the big change occurs passing from 1940 to 2001, reflecting the process of economic expansion following the war and the industrialization and urbanization movements associated with it. In this regard, the 1970s were a dramatic period of change. The contrasts between rural and urban regions and between inland and coastal regions became sharper than ever. During the 1980s and the 1990s, the depopulation of rural areas continued as metropolitan zones expanded.

On all these maps it is visually impossible to distinguish Portugal from Spain. The concentration of population on the Atlantic coast to the North of the Tagus River continues into Galicia in Spain and forms the largest continuous high density area on the Peninsula. Similar trends seem to affect cross-border regions and rural and urban zones in both countries.

The goal of our next step was to confirm spatial population density patterns suggested by previous analysis. Focusing on population density in the three years mentioned, we calculated the Local Moran Indicator to test the spatial autocorrelation of this variable (Figure 3). The 1877/78 map displays a large inland area of the Peninsula dominated by low density clusters. In the South of Portugal, this area reaches to the Atlantic Coast. The map also pinpoints some high density

TABLE 4. Association Between Density Trend Magnitude and Geographical Factors, Measured by the Spearman's Correlation Coefficient (R)

	Population density trend magnitude					
	1877/78–2001		1877/78–1940		1940–2001	
Variable	R	*p* value	R	*p* value	R	*p* value
Temperature	0.4161	.0000	0.4676	.0000	0.2026	.0000
Precipitation	0.1698	.0000	0.2160	.0000	0.0098	.2814
Altitude	−0.4754	.0000	−0.5012	.0000	−0.2787	.0000
Distance to littoral	−0.3289	.0000	−0.3043	.0000	−0.2655	.0000
Distance to main rivers	−0.2777	.0000	−0.2844	.0000	−0.1891	.0000
Distance to Portugal/Spain border	−0.1033	.0000	−0.2401	.0000	0.1932	.0000

clusters, corresponding to urban areas, on the Western Atlantic strip such as Lisbon, Oporto, Vigo, and Corunna as well as on the Spanish Mediterranean Coast such as Barcelona and Valencia. Cities that stand out within the interior of the Peninsula are few, seemingly concentrating themselves in the Northern part and characterized by a negative spatial autocorrelation, combining the high density of the city core with the low density of the surrounding municipalities, as in the cases of Valladolid and Burgos, but especially Madrid. This general pattern is virtually unchanged when we observe the Local Moran Indicator map in 1940. In 2001, the most remarkable difference is the importance of the high density clusters. They correspond to a large share of the most populated urban centers of the Peninsula. The two major cities in the coastal region of both countries (Barcelona and Valencia in Spain; Lisbon and Oporto in Portugal) really stand out, with a pattern that clearly shows the process of suburbanization that affected these centers in the last decades of the twentieth century. The same can be said of Madrid, with the characteristic emptying of the city center being here that much more visible still. Beyond this, the pattern of an ample zone filled with low densities continues throughout the interior of the Peninsula, spreading itself now to include a substantial part of Galicia and of the Northern interior of Portugal.

To characterize the evolution of population density and of the spatial patterns described above, we calculated the density growth trend in the general period and in the two

TABLE 5. Association Between Density Trend and Geographical Factors, by Stratum (Type of Trend), Measured by the Spearman's Correlation Coefficient (R)

		Population density trend					
		1877/78–2001		1877/78–1940		1940–2001	
Type of trend	Variable	R	*p* value	R	*p* value	R	*p* value
Negative	Temperature	−0.4104	.0000	−0.1105	.0000	−0.3265	.0000
Negative	Precipitation	−0.1058	.0000	−0.0441	.0067	−0.1291	.0000
Negative	Altitude	0.4241	.0000	0.1157	.0000	0.3342	.0000
Negative	Distance to littoral	0.3082	.0000	0.2034	.0000	0.1411	.0000
Negative	Distance to main rivers	0.2599	.0000	0.1068	.0000	0.1940	.0000
Positive	Temperature	0.1301	.0000	0.1696	.0000	0.0624	.0003
Positive	Precipitation	0.2492	.0000	0.2283	.0000	0.1360	.0000
Positive	Altitude	−0.4054	.0000	−0.4102	.0000	−0.2867	.0000
Positive	Distance to littoral	−0.4714	.0000	−0.4136	.0000	−0.3832	.0000
Positive	Distance to main rivers	−0.3273	.0000	−0.3128	.0000	−0.2283	.0000

TABLE 6. Association Between Population Density and Distance to the Frontier in the Spanish-Portuguese Border Region (NUTS III), Measured by the Spearman's Correlation Coefficient (R)

Density	R	*p* value
1877/78	−0.0897	.0000
1940	−0.0339	.0584
2001	−0.0069	.7012
Density trend		
1877/78–1940	0.0987	.0000
1940–2001	0.0642	.0003
1877/78–2001	0.0507	.0047

sub-periods, 1877/78–1940 and 1940–2001 (Figure 4). The trend between 1877/78 and 2001 emphasizes the strong growth of the big coastal urban agglomerations as well as of the inland middle-size cities. The map also pictures a certain distinction between the positive evolution of the region South of the Tagus river and opposite trend of the area on the North of the same river. In the first period, it is clear that the urban areas, especially in the coastal regions, were already growing faster, followed by the city of Madrid. The decrease of densities, mainly in values that stay below one inhabitant per km^2 per year, is visible in the Northern part of the Peninsula, tending to affect larger areas in the Northeast and some municipalities along the Spanish Mediterranean coast. In the rest of the Peninsula, the population density is growing. The map of the period between 1940 and 2001 depicts the divide between the inland and the coastal periphery, the former with general negative growth values, punctuated by several "small islands." These ones represent population growth in urban areas surrounded by zones of rural depopulation. The exceptional growth of Madrid and its suburbs stands out. A vigorous upward movement in an almost continuous coastal line surrounding the Peninsula is also noticeable, with the exception of a small part of the Southwest coast of Portugal and of the Cantabrian coast.

At the base of this analysis are three strong long-term trends in population distribution that can be pointed out on the Iberian Peninsula: population concentration on the coast to the detriment of the interior (even taking into account the exceptions previously noted); a more pronounced concentration in the big cities (also, overwhelmingly, situated on the coast and representing a larger population than all the other areas combined); and, finally, a certain contrast between the Northern Peninsula which, globally, seems to lose its population density, and the Southern Peninsula, which, also in general terms, is witnessing an increase in this demographic variable.

Table 1 and Figure 5 help us to understand the evolution that has been described so far. The territories with significant trends represented 54% of the Peninsula's area, divided relatively equally between growth zones and those that lost population. Despite this territorial equilibrium, one observes an accentuated difference in population distribution in these zones in 1877/78. In fact, the parishes and municipalities that were to grow in the period under observation already had twice the resident population that existed in the zones that were to experience a decrease. The changes registered up to 2001 greatly aggravate this inequality and lead to a situation in which more than 80% of the population would come to be concentrated within merely 26% of the Peninsula's territory. At the opposite end of the spectrum, in 2001 the resident population of areas that lost inhabitants (close to 1.8 million), in comparison, would be little more than the number of residents in the municipality of Barcelona (close to 1.5 million), living in 27% of the Peninsula's territory.

In the zones with a trend of increasing population density, we pinpoint two distinct moments of acceleration in this process: passing from 1910/11 to 1920 and, in an even more sharply accentuated way, from 1950 to 1960 (Table 1 and Figure 5). It is notable that in 1920 the population concentrated in these areas already represented 50% of the total population. Analyzing absolute resident population values, the turning point at the middle of the twentieth century is reconfirmed. In fact, until 1950 one sees an incremental population increase in 75% of the Peninsula's area (corresponding to the zones that always grew and to those with a no significant trend, but which did effectively grew until 1940/1950), while after that date population growth would be restricted to little more than 25% of the Peninsula's territory.

Observing population density trend in the period 1877/78–2001 (Figure 4), we already verified that the areas with strong growth corresponded to the large urban agglomerations along the coast, such as Barcelona, Valencia, Alicante, Malaga, Lisbon, Oporto, Vigo, Corunna, Gijón, and Oviedo e Bilbao (each with more than 200,000 residents in 2001), as well as Madrid, obviously, and a small number of medium-sized cities in the interior such as Saragossa, Valladolid, Burgos, and Salamanca (each with more than 150,000 residents in 2001). This is something also visible and consistent with the spatial autocorrelation map of 2001 (Figure 3). Looking at Figure 4, we also pointed to a particular difference between North and South (regions divided by the Tagus River). In the North of the Peninsula, polygons corresponding to the parishes and municipalities that registered a trend of population decrease were (in number) 30% more and (in area) more than double of those that grew. This perspective is reversed in the South of the Peninsula where the parishes and municipalities that grew in density represent more than double in number and almost five times the area of those that experienced a decrease.

By observing the absolute values in Table 1, the graph in Figure 5, and the correlations coefficients in Table 2, it is possible to move forward with one hypothesis in order to explain the spatial distribution and trends described above.

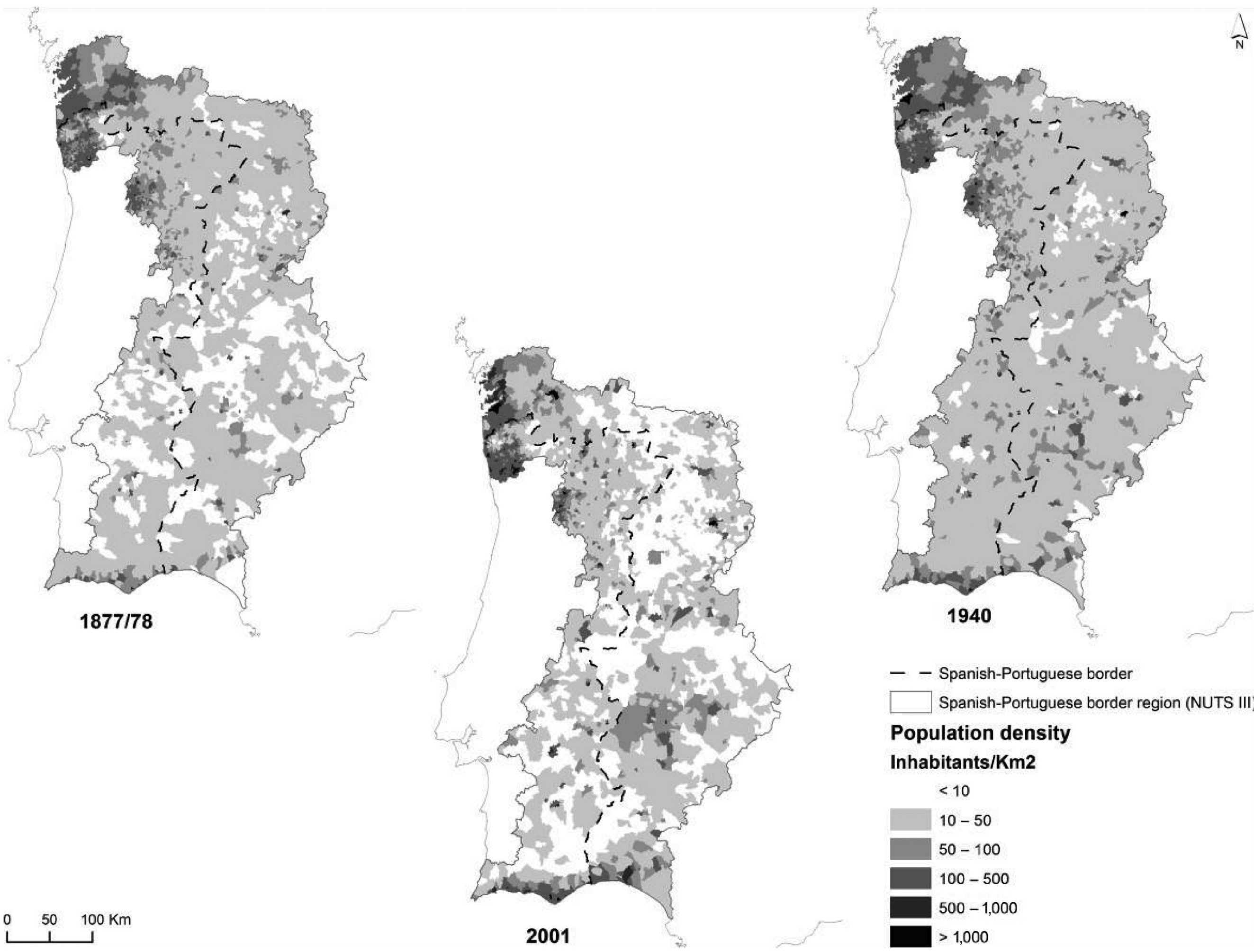

FIGURE 7. Spanish-Portuguese border: Population density in 1877/78, 1940, and 2001.

The first fact to note is that globally, given the value of the Spearman coefficient, the relative position of the parishes and municipalities in 1877/78 is very close to that in 2001. This solidifies the idea expressed in the introduction, now extended to the whole of the Peninsula, at the lowest administrative level of the two countries, in which a significant part of populational attraction, measured by the evolution of the trend of population density, results from a self-sustained process. This means that the agglomerations of the nineteenth century that managed to capture a greater volume of the population are going to be, by this fact and by the dynamics of subsequent political, social, and economic developments, the principal targets of internal migration flows that will, in turn, strengthen and self-nourish a previously visible trend.

In second place, it is obvious that this process was only partially fed by the parishes and municipalities in which the population presented a downward trend. In these cases, there is a visible and almost linear evolution, and the number of inhabitants involved is relatively small (Table 1 and Figure 5). If it is certain that in absolute terms 1910/11 coincides with the year in which these territories begin to lose population in a continuing pattern, it is all the more relevant to observe that the year 1950 represents the same phenomenon in areas with no defined trend. If we pay attention to the fact that the population in these last areas grew from 7 million to almost 10 million residents between 1877/78 and 1950 and then decreased continuously and sharply until 2001 to numbers inferior to initial figures, we understand that essentially, it was here that the previously mentioned gap widened.

Association With Geographical Factors

In the analysis of the relationship between geographical factors and population density values, practically all exercises resulted in statistically significant coefficients for almost all variables and for each observed moment. Seeking

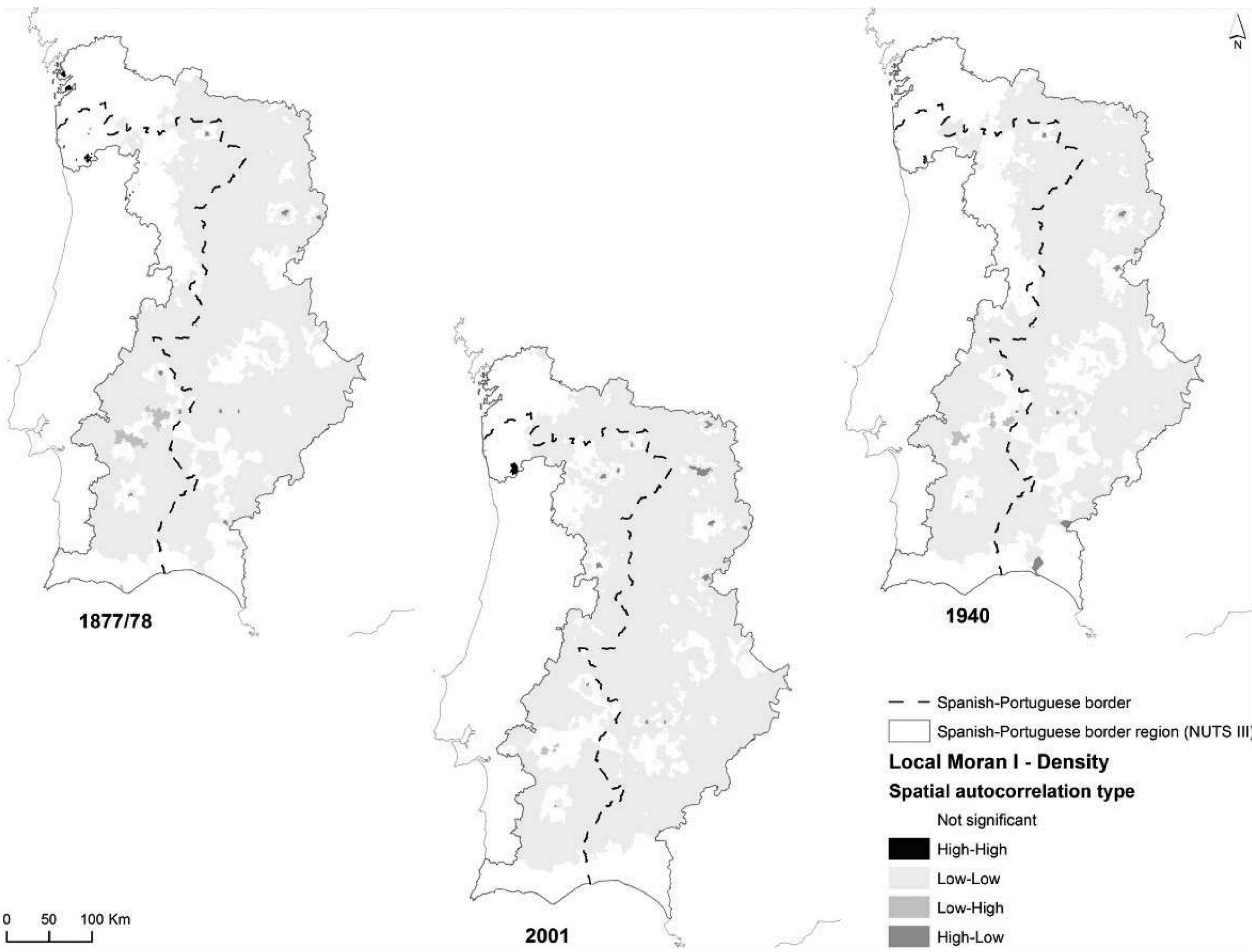

FIGURE 8. Spanish-Portuguese border: Spatial autocorrelation of the population density in 1877/78, 1940, and 2001.

to highlight factors with the greatest intensity of association with spatial distribution of the Iberian Peninsula's population, we selected only the Spearman coefficients with values that were equal to or surpassed 0.4 (–0.4), with two exceptions. The altitude of the parish and municipal main agglomeration was not used as it was apparent that working with territorial divisions of such small scale, the value of the coefficients reflected almost perfectly the average altitude of the polygon, which made its use redundant. In the case of distance to the border, since it would correspond to one of this study's central questions, we considered its analysis pertinent, despite those values being below the indicated limit (Table 3).

Observing Table 3 and Figure 6, we can highlight the importance of median altitude and distance from the shore in the relationship to spatial distribution of the population between 1877/78 and 2001. Aside from presenting slightly lower coefficient values, distance to main rivers is equally relevant. These data lead to the characterization of population distribution in 1877/78 as one of a population with the tendency to concentrate in regions of lower altitude, close to the shore and to the main rivers. Despite noting a certain stability and persistence in the level of association between these factors and the various moments of observing population density, in the case of altitude one sees a progressive and notable building up in the intensity of this relationship throughout the entire period under study, being the only variable to pass the barrier of 0.7 on a scale that oscillates between 0 (no association) and 1 (perfect association).

In factors related to climate, the relationship with the distribution of population density is relatively stable in the case of rainfall, falling slightly in the last observed years. Regarding average temperature, which in the data of the first two censuses had values closely resembling those of rainfall, one notes an evolution very similar to that detected for median altitude, with a notable increase of intensity in this relationship as time goes on. Generally, one could say that population density tended to be greater in regions with a higher annual

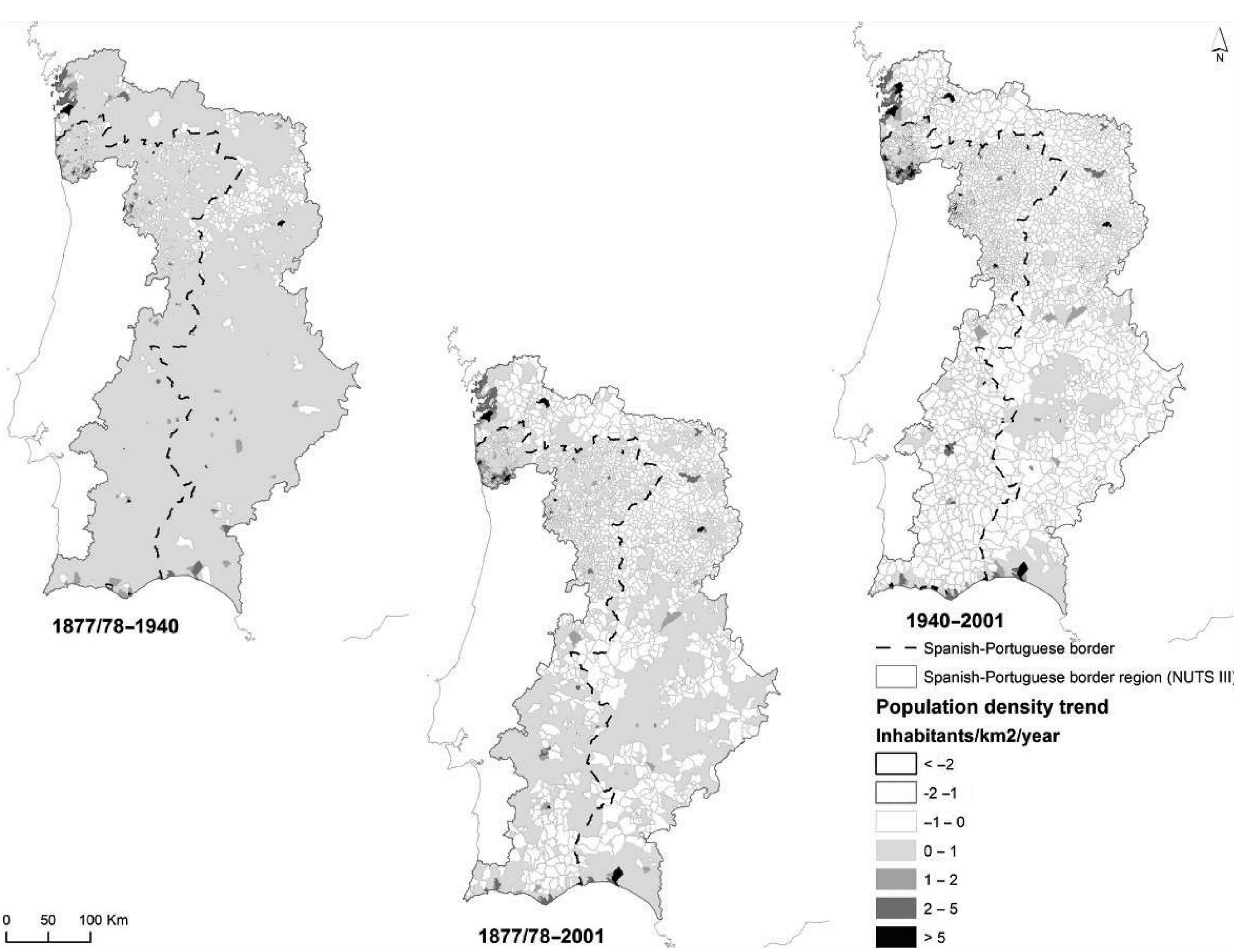

FIGURE 9. Spanish-Portuguese border: Population density trend 1877/78–2001, 1877/78–1940, and 1940–2001.

average temperature. Although less visible comparing the first year and the final year, the relationship of higher population density with greater rainfall begins to lose intensity beginning in the middle of the twentieth century.

As we observed the density map for 1877/78, we had already pointed out a strong tendency for a greater population concentration in coastal regions which, basically, were also the lower-altitude regions and those which had a denser hydrographic network (Figures 1 and 2). The simultaneous presence of these three factors seems to have determined from very early population distribution on the Iberian Peninsula with few exceptions, amongst them Madrid and a handful of medium-sized cities in the interior of the Peninsula.

If it is possible to verify the always statistically significant and intense association between geographical factors and density in each year, when we look at the relationship of the same factors with population density trends, the first conclusion we come to is that in the global period, the associations are on average less intense, only revealing themselves to be relevant (equal or greater than 0.4 [–0.4]) in regards to altitude and average temperatures (Table 4). This intensity diminishes in reference to distance to the coast and even more so with respect to distance to main rivers. Despite the differences in the levels of intensity of the associations, the relationship between various geographical factors and population density trend is similar to that which has already been observed about spatial distribution pattern. It can be affirmed that in general terms, a stronger trend in population density growth is somehow associated with geographical locations that are characterized by simultaneously having a higher average temperature, a lower median altitude, and greater proximity to the coast and main rivers. Association with average rainfall presents values substantially lower than other factors.

It is important to point out that all variables present substantially different behaviors when their intensities are compared within each one of the sub-periods. Without exception, all present a greater intensity of association with density trends during the period 1877/78–1940 than in the following period in which Spearman values all drop in a significant way, in some cases to less than half, becoming statistically not significant as in the case of rainfall (Table 4). This is consistent with the idea that geographical factors, despite continuing to have importance in spatial population distribution in the second half of the twentieth century, lose weight in the explanation of this evolution. This fact would be related with the self-sustaining and cumulative character of population growth previously referred to. Highlighting once again the most relevant intensities of association, perhaps one could assert that between 1877/78 and 1940 the evolution of population distribution was somehow influenced by median altitude and average temperature of the parishes and municipalities, but these factors did not have the same relevance in changes occurring in population density in the period 1940–2001.

In part, we deem that the singular evolution experienced by those areas with a statistically not significant evolution in population trends, to which we have previously referred, could be an explanation for differentiated trends in both sub-periods, once combined with associations to geographical factors. In a primary phase, population increases even in areas where average altitude surpasses 600 meters (Figures 2 and 4), corresponding roughly to the Northern Plateau, the Southern Plateau, and to the Sistema Central and Ibérico, characterized by high plains and some ranges, despite the same occurences on the plains of Alentejo and Andalusia. In a second moment, these same areas lose population amidst a quickening rhythm of population concentration along the coast and in some cities in the interior of the Peninsula (Figures 2 and 3).

Simultaneously, if we focus on the areas with positive and negative general trends (Table 5), we see that the parishes and municipalities that are growing have an association with geographical factors, in particular to those which pertain to altitude and distance from the coast, which are more intense in the first period than in the second, and that this evolution is inverted in the case of parishes and municipalities that see their population density decrease in general with more intense associations in the second period than in the first. This is a finding that is in line with that which was observed in the temporal evolution of population indicators (Table 1 and Figure 5), seemingly pointing to a greater influence of geographical factors as factors for attracting population until the middle of the twentieth century, becoming in the second half of the century factors of repulsion in zones which are losing population on the Iberian Peninsula.

The (Ir)relevance of the Border

As previously observed, associations of spatial distribution of population density within each one of the observed moments with the distance from the Spanish-Portuguese border correspond to the least intense of all variables selected for this study, oscillating between a maximum of –0.27 and a minimum of –0.17 (Table 3). However, it is necessary to mention that these calculations are clearly influenced by the inclusion of all the territory of the Iberian Peninsula. Distortions are introduced into the analysis not only because the lesser distance between the coast and the border in the Portuguese case increases population concentration values which are taken into account in the association with proximity to the border, but also due to the reverse phenomenon when one includes very distant regions in the analysis, such as Saragossa and Barcelona also characterized by a high density.

Therefore, we had to devise a way to isolate the effect of the frontier on the Spearman coefficient calculations. It is difficult to delimit cross-border regions based on such small size units as parishes and municipalities. The combination of Portuguese districts and Spanish provinces was not an alternative, since the use of the former would entail the inclusion of areas far away from the frontier. The most satisfactory solution to overcome these problems seemed the adoption of the NUTS III existing in 2001, which in Spain correspond to the provinces and in Portugal to units smaller than the districts. After defining the area to be analyzed, we took into consideration the parishes and municipalities contained in those divisions and recalculated all the Spearman's coefficients (Table 6).

The first conclusion to be drawn is that the weak association between distribution of population density and distance to the border when considering the whole Peninsula became practically non-existent when we narrow our attention on the border region. All Spearman's values come very close to zero, falling over time and, in the case of associations with density in 1940 and 2001, resulting in statistically not significant values. In the case of trends, whether general or those of the sub-periods, they prove to be equally very weak, always inferior to 0.10 (Table 6).

These observations support the hypothesis that proximity to the border did not generate any distinct pattern in population density, whether in terms of spatial distribution or in the temporal evolution. Basically, it was the fact of being near or far from the coast, of having high or low altitude, or of being distant or close to the rivers that influenced values of population density in this region.

Observation in greater detail of the density distribution, spatial autocorrelation, and trend maps, now with the boundary line drawn (Figures 7, 8, and 9), allows for the verification of three relevant aspects of this "porous demographic" Spanish-Portuguese border. On one hand, the border zone is not uniform when it comes to population distribution, quite the opposite. We are not talking about a single border region but more realistically about three distinct regions, encompassing the Northern coastal area between Galicia and Minho, the central interior that goes from the districts of Vila Real to Beja on the Portuguese side and the provinces of Zamora to Badajoz on the Spanish one, and finally the Southern coastal zone of Algarve and Huelva.

On the other hand, we see that whatever the statistical measure considered, the density pattern and trend on both sides of the border in each of the three suggested sub-regions is similar (Figures 7, 8, and 9). If we focus only on density values in the three years selected, we observe a significant strengthening in population relocation on the Northern and Southern coasts, as well as a dual trend in the central interior region with a rise in density up until the middle of the twentieth century and a subsequent decline accompanied by a concentration phenomenon in medium-sized cities, as is the case of Bragança and Zamora, Guarda and Salamanca, Castelo Branco and Plasencia, Evora and Badajoz.

Finally, spatial distribution of the three measures (density, spatial correlation, and trend) in the three suggested sub-regions is no more than the continuation of a spatial pattern that is visible in the wider areas on either side of the border, which the frontier does not break (Figures 7, 8, and 9, compare respectively to Figures 2, 3, and 4). The population movement toward the coast referred to on both sides of the border is much a part of an extensive phenomenon that can be seen on the Atlantic Coast, for example, from Corunna to Setubal. In the inland, the growth and subsequent decline that occurs, for example, in the border region between Extremadura and Alentejo, begins in Castilla-La Mancha and extends itself to the Alentejo coast.

Conclusion

In Portugal and Spain, the modernization process began with the liberal revolutions of the 1830s. In fact, these revolutions implied a profound institutional change that created the conditions for the development of a capitalist economy. Gradually, the two countries then watched the transformation of their economies, driven by the spread of railways and of industry, a process that was accompanied by urban growth. However, until the first half of the twentieth century these developments were relatively moderate, especially compared to what occurred after the Second World War, a time of significant economic growth and structural transformation, which included a vigorous urban development and major movements of rural-urban migration.

This work confirmed the existence of a pattern of population distribution common to the whole Iberian Peninsula. In fact, Local Moran indicator maps identified a persistent large zone of low population density clusters, extending from the Pyrenees to the South of Portugal. With the exception of some areas, where it stretches to the sea, this low population density zone corresponds to the inland of the Peninsula. Its densities contrast with coastal ones, where urban life has strongly developed. We also found that this pattern of distribution evolved similarly in the peninsular territory. We have also seen that this development did not substantially alter the relative positions of the parishes and municipalities regarding values of population density between the beginning and end of the study period, a fact which had been registered for Spain as stated in the introduction.

The pattern of population distribution is clearly associated with geographical factors, in particular, altitude, distance from shore, distance to main rivers, temperature, and precipitation. These factors seem to have more weight in explaining changes between 1877/78 and 1940 than in the following period. The explanation suggested by Ayuda et al. (2010b) for a similar observation in relation to Spain may be valid regarding the Iberian Peninsula as a whole. In fact, geography would have strongly conditioned population location in the period prior to modern economic growth. When this began, economic activity tended to concentrate in the more populated areas. The latter will benefit from migratory movements, economies of scale, and lowering transport costs and thus will grow faster than others. In this context, as time goes on geographical factors continue to be of importance but decrease their explanatory weight.

Lastly, the observation of the cross-border region has shown that proximity to the frontier has not generated, either in the spatial distribution of population density or in the temporal evolution, any distinct pattern on either side of the boundary line. This is consistent with what Maria Moreira (2001) said on the demographic behavior of these areas throughout the twentieth century. In reality, the density in border areas seems to be influenced by geographical factors and economic forces that are felt in the wider regions where those areas are integrated, which act similarly on both sides of that political divide.

The spatial coherence of the observed phenomena throughout the Peninsula and of its evolution, independent of the border between states, reinforces the importance of geographic factors in their explanation. At the same time, this verification opens up new issues related to the effect of economic policies, particularly in two areas related to the morphology of the territory and resources (i.e., transport and agriculture): Were they very different, yet without contravening the natural constraints? Or, as it seems to have been the case, were they identical and parallel in time? If so, what is the explanation for their similarity and simultaneity? The answer to this last question should probably be sought in the insertion of two states in the international political and economic context.

NOTES

1. Information available at http://www.igeo.pt/produtos/cadastro/caop/caop_vigor.htm and http://centrodedescargas.cnig.es/CentroDescargas/equipamiento.do?method=mostrarEquipamiento.
2. http://www.opengis.uab.es/wms/iberia/en_index.htm_
3. Population of a parish in the initial year was allocated to the corresponding parishes of the target year, according to the weight of each of the latter in the total population of this set of units in 2001.

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